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(54) HYDRAULIC VALVE FOR USE IN A CONTROL MODULE OF AN AUTOMATIC TRANSMISSION

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CPC F16K 31/0613 (2013.01); F16H 61/0251 (2013.01); F16K 11/07 (2013.01); F15B 2013/004 (2013.01); F16H 2061/0253

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See application file for complete search history.

(56) References Cited

(10) **Patent No.:**

(45) Date of Patent:

U.S. PATENT DOCUMENTS

1,233,561 A 7/1917 Dornfeld 2,174,395 A 9/1939 Aikman (Continued)

FOREIGN PATENT DOCUMENTS

DE 871857 7/1949 DE 953406 11/1956 (Continued)

OTHER PUBLICATIONS

Raw Machine translation for Foreign Patent Document JP-2000-220762.*

(Continued)

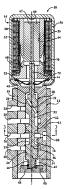
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(57) ABSTRACT

A hydraulic valve assembly (10) adapted to be mounted to a transmission control module (15) and having a valve body (12), a valve bore (16), and at least one pressure supply port (26) as well as at least one pressure control port (28) that establish fluid communication between a source of pressurized fluid and a component to be controlled by the valve assembly. A valve member (18) is supported in the valve bore (16) and is selectively movable between predetermined positions to direct the pressurized fluid between the pressure supply port (26) and the pressure control port (28). In addition, the hydraulic valve assembly (10) includes a biasing mechanism (80, 180, 280, 380) that is responsive to the flow of hydraulic fluid through the valve body to generate a biasing force acting on the valve body (12) in a direction toward the pressure supply port (26).

4 Claims, 7 Drawing Sheets





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(51)	Int. Cl.			4,947,970			Miller et al.
	F15B 13/04		(2006.01)	4,957,016			Amedei et al.
	F16K 31/06		(2006.01)	4,976,594			Bernstrom
	F16H 61/02		(2006.01)	5,050,714 5,069,656			Kurihara et al. Sherman
	F15B 13/00		(2006.01)	5,152,726			Lederman
	1 13D 13/00		(2000.01)	5,174,420			DeWald et al.
(50)		Deferen	one Cited	5,232,411			Hayashi et al.
(56)		Referen	ices Cited	5,247,965			Oka et al 137/625.65
	IIC	DATENIT	DOCUMENTS	5,250,011		10/1993	
	0.3.	FAILINI	DOCUMENTS	5,259,476	Α	11/1993	Matsuno et al.
	2,639,013 A	5/1053	Meschia				Patton et al 137/625.64
	2,702,049 A		Seeloff	5,261,803			Freeman
	2,919,778 A		Aschauer	5,275,267			Slicker
	2,943,502 A		Perkins et al.	5,282,722 5,284,232		2/1994	Prud'Homme
	3,040,408 A	6/1962		5,299,920			Stearns
	3,053,051 A	9/1962	Kelley	5,305,863			Gooch et al.
	3,171,522 A		Petrie et al.	5,383,544		1/1995	
	3,313,385 A	4/1967	Föster	5,395,217		3/1995	Hoffmann et al.
	3,362,481 A 3,490,312 A	1/1968	Steinhagen Seitz et al.	5,413,470			Eisenmann
	3,534,824 A		Davison, Jr.	5,439,088			Michioka et al.
	3,537,556 A		Pfeffer et al.	5,444,623			Genise
	3,589,483 A	6/1971		5,445,043			Eaton et al. Maucher
	3,612,237 A	10/1971	Honda	5,450,934 5,469,943			Hill et al.
	3,654,692 A	4/1972	Goetz	5,474,428			Kimura et al.
			Evans	5,476,374			Langreck
	3,760,918 A		Wetrich et al.	5,495,927			Samie et al.
	3,823,801 A		Arnold Maurer et al.	5,499,704	A	3/1996	
	3,834,503 A 3,858,698 A	1/1975		5,505,286		4/1996	
	4,023,444 A		Murakami	5,522,775			Maruyama et al.
	4,081,065 A	3/1978	Smyth et al.	5,538,121			Hering
	4,155,535 A	5/1979	Seamone	5,554,019 5,577,588		9/1996	Raszkowski
	4,205,739 A		Shelby et al.	5,584,776			Weilant et al.
	4,219,246 A	8/1980		5,609,067			Mitchell et al.
	4,220,178 A		Jackson	5,613,588		3/1997	
	4,270,647 A 4,295,792 A	6/1981	Tachibana et al.	5,630,773			Slicker et al.
	4,301,904 A	11/1981		5,634,541			Maucher
	4,361,060 A	11/1982		5,634,867		6/1997	
	4,372,434 A		Aschauer	5,662,198 5,679,098			Kojima et al. Shepherd et al.
	4,445,393 A	5/1984		5,711,409			Murata
	4,449,416 A		Huitema	5,720,203			Honda et al.
	4,458,318 A	7/1984 7/1984	Smit et al.	5,732,736		3/1998	Ollivier
	4,461,188 A 4,476,748 A		Morscheck	5,755,314			Kanda et al.
	4,501,676 A		Moorhouse	5,782,710			Kosik et al.
	4,513,631 A		Koivunen	5,806,643		9/1998	
	4,540,078 A		Wetrich	5,823,909 5,830,102		11/1998	Beim et al.
	4,540,347 A	9/1985		5,851,164		12/1998	Habuchi et al.
	4,544,057 A		Webster et al.	5,890,392		4/1999	Ludanek et al.
	4,548,306 A 4,557,363 A	10/1985 12/1985		5,899,310	Α	5/1999	Mizuta
	4,622,866 A		Ito et al.	5,908,100			Szadkowski et al.
	4,627,312 A		Fujieda et al.	5,911,400			Niethammer et al 251/129.08
	4,646,891 A	3/1987		5,915,512 5,918,715			Adamis et al. Ruth et al.
	4,653,348 A		Hiraiwa	5,928,104			Kimura et al.
	4,662,249 A		Miki et al.	5,944,042		8/1999	
	4,667,534 A		Kataoka	5,950,781		9/1999	Adamis et al.
	4,667,798 A		Sailer et al.	5,964,675	Α		Shimada et al.
	4,680,987 A 4,683,915 A *	7/1987 8/1087	Morimoto Sloate 137/625.63	5,966,989		10/1999	
	4,700,823 A		Winckler	5,979,257		11/1999	
	4,713,980 A		Ida et al.	6,000,510			Kirkwood et al.
	4,719,998 A	1/1988	Hiramatsu et al.	6,006,620 6,012,561			Lawrie et al. Reed, Jr. et al.
	4,722,237 A	2/1988	McNinch, Jr.	6,026,944			Satou et al.
	4,732,253 A		Hiramatsu et al.	6,044,719			Reed, Jr. et al.
	4,747,744 A		Dominique et al.	6,059,534			Kotake et al.
	4,753,332 A 4,766,774 A	6/1988 8/1988	Bieber et al.	6,062,361			Showalter
	4,766,774 A 4,790,418 A		Brown et al.	6,065,363		5/2000	Schaller et al.
	4,802,564 A	2/1989		6,071,211			Liu et al.
	4,808,015 A		Babcock	6,095,941			Martin et al.
	4,827,784 A	5/1989	Muller et al.	6,105,448			Borschert et al.
	4,841,803 A	6/1989	Hamano et al.	6,109,410		8/2000	
	4,905,801 A		Tezuka	6,116,397			Kosumi et al.
	4,911,031 A 4,941,508 A		Yoshimura et al. Hennessy et al.	6,135,919 6,145,398			Shimakura Bansbach et al.
	7,271,300 A	7/1990	mennessy et al.	0,143,398	A	11/2000	Dansuach et al.

US 9,086,170 B2 Page 3

U.S. PATENT DOCUMENTS 2003/007541 Al 2003 Affredson 6,164,149 A 12,2000 Olmori et al. 6,164,120 Bl 1 2001 Runchel 6,188,209 Bl 1 2001 Runchel 6,188,209 Bl 2,2001 Runch 6,188,209 Bl 2,2001 Runchel 6,188,209 Bl 2,2001 Runchel 6,289,289 Bl 2,2001 Runchel 6,289,289 Bl 2,2001 Runchel 6,276,269 Bl 2,2001 Runchel 6,276,269 Bl 2,2001 Runchel 6,276,269 Bl 2,2001 Runchel 6,276,269 Bl 2,2001 Runchel 6,289,289 Bl 2,2002 Runchel 6,389,289 Bl 2,2002 Runchel 6,389,349 Bl 1,2002 Runchel 6,389,349 Bl 2,2002 Runchel 6,389,349 Bl 2,2002 Runchel 6,389,349 Bl 2,2002 Runchel 6,489,249 Bl 2,2003 Runchel 6	(56)	References Cited							Berger et a		
Color	-	IIS P	ATENT	DOCUMENTS							
Gel. 149 A 122005 Dimori et al. 2004-0006378 Al 42004 Damanto et al.		0.5.1.	ALL LIVE	DOCOMENTS							
6.188,699 Bl 22901 Ruth	6,164,149	A									
6.189.669 Bl 22001 Kenner et al. 2004-0153025 1 72002 Commental et al. 2004-0153025 1 72002 Commental et al. 2004-0153025 1 72002 Commental et al. 2005-0007672 h. 1 62005 Friedmann et al. 2006-0007773 h. 1 62005 Friedmann et al. 2007-0007773	6,171,212	B1			2004/006037	78 A	.1 4/2	2004	Yamamoto	et al.	
Color											
6.227,063 Bi \$2001 Ohmori et al. 2005/000774 Al 1 12005 Friedmann 6.244,079 Bin Group Friedmann 6.244,079 Bin Group Friedmann 6.246,073 Bin 6.2001 Cornea et al. 2005/000721 Al 1 12005 Segi et al. 137/625.65 2005/000763 Al 1.27005 Segi et al. 137/625.65 2005/000763 Al 1.27005 Segi et al. 137/625.65 2005/000763 Al 1.27005 Segi et al. 2005/000763 Al 1.27005 S										et al.	
September Sept	6,217,479	B1							~		
6.269.878 BI * 82001 Orice et al. 2005.0279.05 1 22005 Segi et al. 137/625.65 6.276.224 BI 8 * 82001 Cetal et al. 2006.000604 1 22005 Sewal et al. 6.286.88 9.2001 Cetal et al. 2006.000604 1 12006 Recipit et al. 6.290.565 BI 102001 Letal et al. 2006.000604 1 12006 Recipit et al. 6.321,612 BI 112001 Leimbach et al. 2006.000604 1 12006 Segi et al. 6.343,637 BI 12002 Lenzi 2006.000604 1 12006 Segi et al. 6.346,608 BI 22002 Cenzi 2006.000120 A 12000 Segi et al. 6.348,008 BI 42002 Cherry 2006.001402 A 12000 Segi et al. 6.348,008 BI 42002 Cherry 2006.001402 A 12000 Segi et al. 6.378,302 BI 42002 Conza 2007.0024019 A 120007 Carlson 6.489,10 BI 42002 Cherry 2006.0014024 A 12000 Segi et al. 6.490,002 BI 72002 Conve 2007.0024019 A 120007 Carlson 6.412,539 BI 82002 Sewen 2009.0023783 A 42006 Segi et al. 6.412,539 BI 82002 Sewen 2009.0023783 A 42000 Segi et al. 6.435,243 BI 82002 Levi et al. 2009.0000773 A 12009 Dahaime et al. 6.438,932 BI 82002 Sewen 2009.0023783 A 42000 Segi et al. 6.435,243 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.438,932 BI 82002 Levi et al. 2009.0023783 A 42000 Segi et al. 6.439,643 BI 2009.003 Segi et al. 2009.003783 A	6,227,063	BI B1								et al	
Section Sect											137/625.65
6.298,538 B1 0 2000					2005/027960)5 A			_		
6.295, 685 Bil 10/2001 Miyake et al. 6.295, 685 Bil 10/2001 Jain et al. 6.295, 685 Bil 10/2001 Jain et al. 6.236, 678 Bil 10/2001 Leimbach et al. 6.236, 678 Bil 11/2005 Sengel et al. 6.336, 781 Bil 1/2005 Sengel et al. 6.336, 781 Bil 1/2005 Sengel et al. 6.336, 781 Bil 4/2002 Sengel et al. 6.336, 781 Bil 4/2002 Sengel et al. 6.336, 781 Bil 4/2002 Sengel et al. 6.336, 781 Bil 4/2005 Sengel et al. 6.336, 781 Bil 4/2002 Sengel et al. 6.336, 781 Bil 4/2002 Sengel et al. 6.336, 781 Bil 4/2002 Sengel et al. 6.339, 791 Bil 5/2002 Sengel et al. 6.339, 791 Bil 5/2002 Sengel et al. 6.339, 791 Bil 5/2002 Sengel et al. 6.430, 791 Bil 5/2002 Senge										al.	
6.299,565 B1 10/2001 Jain et al. 2006/00/09326 A1 12/2006 Steffna											
Company		B1	10/2001	Jain et al.					_	П.	
6.349.008 B1 2/2002 Cherry 2006/0014624 Al 4/2006 Cabowskie et al.			1/2001	Leimbach et al.						et al.	
6.378.302 B1 4/2002 Nozawa et al. 6.378.302 B1 4/2002 Nozawa et al. 6.378.303 B1 5/2002 Fukuda 6.389.916 B1 5/2002 Sommer et al. 6.399.916 B1 5/2002 Sommer et al. 6.399.916 B1 7/2002 Hubbard et al. 6.399.916 B1 7/2002 Grove 6.479.503 B1 8/2002 Brown 2009/02578 A1 3/2009 Van Weelden 251/12 6.479.503 B1 8/2002 Janasek et al. 6.479.504 B1 8/2002 Janasek et al. 6.435.213 B2 8/2002 Journal of the state of the			2/2002	Lenzi							
6,389,916 B1 5/2002 Fukuda 2007/0284213 A1 12/2007 Danalmine et al. 6,415,213 B1 7/2002 Hubbard et al. 2009/090677 A1 12/2009 Inagume et al. 6,415,213 B1 7/2002 Fukuda et al. 2009/0905783 A1 3/2009 Van Weelden 251/12 6,427,550 B1 8/2002 Bowen 2009/09232673 A1 9/2009 Reisch et al. 6,435,213 B2 8/2002 Lou FOREIGN PATENT DOCUMENTS 6,435,213 B2 8/2002 Nozawa et al. 6,463,221 B1 10/2002 Reed, it et al. DE 11/18/14 11/18/14 6,463,321 B1 10/2002 Reed, it et al. DE 11/18/14 11/18/14 6,463,321 B1 10/2002 Reed, it et al. DE 11/18/14 11/18/14 6,463,321 B1 10/2002 Reed, it et al. DE 11/18/18 6,463,321 B1 10/2002 Nozawa et al. DE 11/18/18 6,463,321 B1 10/2003 Secd, it et al. DE 3/18/18/18 6,409,044 B1 10/2002 Nozawa et al. DE 3/18/18/18 6,523,657 B1 3/2003 Sakamoto et al. DE 3/18/18/18 6,523,657 B1 3/2003 Sakamoto et al. DE 19/30/635 C2 8/1997 6,552,056 B2 8/2003 Sakamoto et al. DE 19/30/635 C2 8/1997 6,660,161 B2 8/2003 Secdit DE 10/18/18 C1 2/1998 6,619,152 B2 9/2003 Obhet et al. DE 10/18/18 C1 2/1998 6,619,152 B2 9/2003 Obhet et al. DE 10/18/18 A1 2/2002 6,663,163,163 B2 10/2003 Obhet et al. DE 10/18/18 A1 2/2002 6,663,596 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,665,0596 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,665,396 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,665,396 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,669,396 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,669,396 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,669,396 B1 12/2003 Secdit DE 10/18/18 A1 2/2002 6,679,397 B2 2/2004 Kopec et al. DE 10/18/18 A1 2/2003 6,793,248 B2 2/2004 Kopec et al. DE 10/18/18 A1 2/2003 6,793,248 B2 2/2004 Kopec et al. DE	6,364,809	B1	4/2002	Cherry						et al.	
6.415.21 Bl 7.2002 Crowe 2009:0057583 Al* 3/2009 Van Weelden											
6.415.213 B1 7.2002 Hubbard et al. 2009/0057583 A1 3/2009 Meedden											
6.419.002 B1	6,415,213	B1	7/2002	Hubbard et al.							251/12
0.42, 2.30 B 8, 200. Lamasek et al.											231/12
6,433,213 B2 8/2002 Douglet FOREIGN PATENT DOCUMENTS											
6,43,821 BI 10/2002 Reed, Jr. et al. DE 1146314 3/1963 6,470,764 BI 10/2002 Yamaguchi et al. DE 3149880 C2 7/1982 6,640,944 BI 12/2002 Heinzel et al. DE 3149880 C2 7/1982 6,523,657 BI 2/2003 Kundermann et al. DE 3149880 C2 7/1982 6,527,074 BI 3/2003 Sundermann et al. DE 3532759 CI 3/1987 6,651,796 BE 2/2003 Sakamoto et al. DE 19631983 CI 2/1998 6,615,966 BE 2/2003 Kato DE 19631983 CI 2/1998 6,615,966 BE 2/2003 Kato DE 19034677 AI 2/2002 6,628,065 BE 2/2003 Albert et al. DE 10034677 AI 2/2002 6,638,165 BE 10/2003 Petrik DE 10118756 AI 3/2002 6,638,165 BE 10/2003 Ogawa et al. DE 10118756 AI 3/2002 6,638,167 BE 10/2003 Ogawa et al. DE 10118756 AI 3/2002 6,669,576 BI 12/2003 Sefcik DE 10115778 AI 1/2002 6,669,576 BI 12/2004 Koneig et al. DE 1014384 AI 3/2003 6,669,574 BE 2/2004 Koneig et al. DE 1014384 AI 3/2003 6,695,748 BE 2/2004 Koneig et al. DE 1014384 AI 3/2003 6,797,576 BI 3/2004 Usoro et al. EP 0762009 AI 3/1997 6,736,751 BI 3/2004 Usoro et al. EP 1195337 AI 4/2002 6,789,658 BE 2/2004 Busold et al. EP 1195337 AI 4/2002 6,789,658 BE 2/2004 Busold et al. EP 1195337 AI 4/2002 6,883,394 BE 1/2004 Busold et al. EP 1733178 A2 9/2006 6,883,394 BE 3/2005 Brieford, Jr ER 1246517 DI/906 6,883,394 BE 3/2005 Brieford, Jr ER 1990076 AI 7/2008 6,899,938 BE 2/2004 Suchanan et al. EP 1793078 AI 4/2002 6,883,394 BE 3/2005 Sefcik BI P 200020076 AF 3/2007 6,898,992 BE 3/2005 Sefcik BI P 20008159 A 7/2007 6,997,766 BE 20/2006 Sefcik BI P 20008159 A 7/2007 6,997,766 BE 20/2006 Sefcik BI P 20008159 A 7/2007 6,997,766 BE 20/2006 Sefcik BI P 20008159 A 7/2007 6,997,766	6,435,213	B2	8/2002	Lou	F	ORI	EIGN P.	ATE	NT DOCU	MENTS	
6,470,764 B1 10/2002 Heinzel et al. DE 31/48/80 C					DE	1	1146214		2/1062		
6.490.944 Bl 1/2002 Heinzel et al. DE 314/9880 C2 7/1982 6.523.657 Bl 2/2003 Kunderman et al. DE 318/565 All 1/1982 6.527.074 Bl 3/2003 Morishita DE 353/2759 C1 3/1987 6.536.208 B2 3/2003 Sakamoto et al. DE 1970/635 C2 8/1997 6.602.161 B2 8/2003 Returningsen et al. DE 1963/1983 C1 2/1998 6.615.966 B2 9/2003 Kato DE 1001/2122 All 2/2002 6.619.152 B2 9/2003 Albert et al. DE 1003/4677 Al 2/2002 6.620.366 B2 9/2003 Albert et al. DE 1003/4677 Al 2/2002 6.638.197 B2 10/2003 Petrzik DE 10118756 Al 5/2002 6.638.197 B2 10/2003 Matsumura et al. DE 10118756 Al 8/2002 6.665.609 B1 12/2003 Secfik DE 10115778 Al 8/2002 6.668.537 B2 2/2004 Koenig et al. DE 10125772 Al 11/2002 6.695.748 B2 2/2004 Koenig et al. DE 10125772 Al 11/2002 6.736.751 B1 4/2004 Buchanan et al. EP 0120617 Al 10/1984 6.751.731 B1 5/2004 Elich et al. EP 0120617 Al 10/1984 6.752.731 B1 5/2004 Elich et al. EP 0126617 Al 10/1984 6.752.731 B1 9/2004 Elich et al. EP 1195537 Al 4/2002 6.789.658 B1 9/2004 Elich et al. EP 1195537 Al 4/2002 6.789.658 B1 9/2004 Elich et al. EP 1731/78 Al 9/2006 6.819.979 B2 1/2004 Buchanan et al. EP 1731/78 Al 9/2006 6.819.979 B2 1/2004 Buchanan et al. EP 17903/78 Al 9/2006 6.830.51 B1 1/2004 Buchanan et al. EP 17903/78 Al 9/2006 6.831.978 B2 1/2004 Buchanan et al. EP 17903/78 Al 9/2006 6.832.978 B2 1/2004 Buchanan et al. EP 17903/78 Al 9/2006 6.833.94 B2 2/2004 Buchanan et al. EP 17903/78 Al 9/2006 6.833.95 B2 6/2005 Braford, Jr. GB 2/306/30 Al 1/2001 6.935.666 B2 1/2006 Braford, Jr. GB 2/306/30 Al 1/2001 6.935.666 B2 1/2008 Skinet et al. P 2001/20108 Al 1/2001 7.177.961 B2 1/2006 Skinet et al. P 2001/20108 Al 1/2001 7.187.978 B											
6.537,074 B1 3/2003 Morishita DE 353279 CI 3/1987								C2			
6.602,161 B2											
Geol. Geol											
Color Colo											
6.626,056 B2 9,2003 Albert et al. DE 10049474 A1 4/2002											
Color											
6,656,090 B2											
6,669,596 Bl 12/2003 Sefcik DE 10125172 Al 11/2002											
6,685,478 B2 2/2004 Koenig et al. DE 10143834 Al 3/2003											
6,715,597 BI 4/2004 Buchanan et al. EP 0762009 AI 3/1997 6,736,751 BI 5/2004 Usoro et al. EP 0848179 AI 6/1998 6,736,751 BI 5/2004 Usoro et al. EP 1195537 AI 4/2002 6,789,658 B2 9/2004 Busold et al. EP 1195537 AI 4/2002 6,789,658 B2 9/2004 Busold et al. EP 1420185 A2 11/2003 6,799,159 BI 9/2004 Yamamoto EP 1531292 A2 11/2004 6,792,821 BI 9/2004 Buchanan et al. EP 1531292 A2 11/2004 6,819,997 B2 11/2004 Buchanan et al. EP 1703178 A2 9/2006 6,830,31 BI 12/2004 Buchanan et al. EP 1788288 A2 5/2007 6,833,513 BI 12/2004 Buchanan et al. EP 1788288 A2 5/2007 6,834,562 B2 12/2004 Esty et al. EP 1950076 AI 7/2008 6,834,562 B2 12/2004 Esty et al. FR 1246517 10/1960 6,868,949 B2 3/2005 Erising et al. GB 2036203 A 6/1980 6,883,394 B2 4/2005 Koenig et al. GB 2036203 A 6/1980 6,883,394 B2 5/2005 Buchanan et al. JP 4366032 12/1992 6,898,992 B2 5/2005 Buchanan et al. JP 82003393 8/1996 6,993,417 B2 10/2005 Koenig et al. JP 82003393 8/1996 6,953,417 B2 10/2005 Koenig et al. JP 2001206108 A 7/2001 6,953,417 B2 10/2005 Koenig et al. JP 2001206108 A 7/2001 6,953,417 B2 10/2005 Koenig et al. JP 2001206108 A 7/2001 6,953,417 B2 10/2005 Koenig et al. JP 2001206108 A 7/2001 6,959,438 B2 11/2005 Hirat et al. 251/129.15 JP 2004-176895 A 6/2004 7,007,925 B2 * 3/2006 Nordstrom et al. 251/129.15 JP 2004-176895 A 6/2004 7,007,925 B2 * 3/2006 Koenig et al. JP 20098159 A 1/2009 7,127,961 B2 10/2006 Brafford et al. JP 2009908159 A * 1/2009 7,127,961 B2 10/2008 Segi et al. JP 2009908159 A * 1/2009 7,219,571 B2 5/2007 Koenig et al. WO 2004005744 AI 1/2004 7,311,187 B2 1/2008 Kaing et al. WO 2004005744 AI 1/2004 7,311,187 B2 1/2007 Koenig et al. WO 2006086704 A2 8/2006 7,431,043 B2 10/2008 Sign et al. MO 2006086704 A2 8/2006 7,431,043 B2 10/2008 Sign et al. MO 2006086704 A2 8/2006 7,431,043 B2 10/2008 Diemer et al. Bairchet al. MO 2006086704 A2 8/2006 7,431,043 B2 10/2008 Diemer et al. Bairchet al. MO 200608704 AI 1/2009 7,219,571 B2 5/2007 Mo Crary WO 200608704 AI 1/2009 7,219,571 B2 5/2007 Diemer et al. Bairchet al. BEP 119503706 AI 10/2009 7,1	6,685,437	B2	2/2004	Koenig et al.							
6,736,751 Bl 5 5/2004 Usoro et al. EP 0848179 A1 6/1998 6,752,743 B2 6/2004 Eich et al. EP 1195537 A1 4/2002 6,789,658 B2 9/2004 Busold et al. EP 1420185 A2 11/2003 6,790,159 B1 9/2004 Busold et al. EP 1531292 A2 11/2004 6,792,821 B1 9/2004 Wamamoto EP 1703178 A2 9/2006 6,819,997 B2 11/2004 Buchanan et al. EP 1788288 A2 5/2007 6,830,531 B1 12/2004 Buchanan et al. EP 1788288 A2 5/2007 6,833,545 B2 12/2004 Eisly et al. EP 1950076 A1 7/2008 6,834,562 B2 12/2004 Eisly et al. FR 1246517 10/1960 6,854,562 B2 3/2005 Braford, Jr. GB 2036203 A 6/1980 6,869,382 B2 3/2005 Leising et al. GB 2036203 A 6/1980 6,883,394 B2 5/2005 Buchanan et al. JP 4366032 12/1992 6,888,394 B2 5/2005 Buchanan et al. JP 8200393 8/1996 6,899,955 B2 6/2005 Vukovich et al. JP 8200393 8/1996 6,999,955 B2 6/2005 Vukovich et al. JP 2001220762 A * 8/2000F16K 31/06 6,953,417 B2 10/2005 Koenig et al. JP 2001220765 A 9/2003 6,969,043 B2 * 11/2005 Koenig et al. JP 2001220765 A 9/2003 6,969,043 B2 * 11/2005 Hirata et al											
6,752,743 B2 6/2004 Eich et al. EP 1195537 A1 4/2002 6,789,658 B2 9/2004 Busold et al. EP 1420185 A2 11/2003 6,799,159 B1 9/2004 Buchanan et al. EP 1531292 A2 11/2004 6,819,997 B2 11/2004 Buchanan et al. EP 1703178 A2 9/2006 6,819,997 B2 11/2004 Buchanan et al. EP 1703178 A2 9/2006 6,832,978 B1 12/2004 Koenig et al. EP 1788288 A2 5/2007 6,832,978 B2 12/2004 Buchanan et al. EP 1500076 A1 7/2008 6,832,978 B2 12/2004 Buchanan et al. FR 1246517 10/1960 6,834,62 B2 12/2004 Buchanan et al. FR 1246517 10/1960 6,834,62 B2 3/2005 Braford, Jr. GB 2036203 A 6/1980 6,869,382 B2 3/2005 Coenig et al. GB 2036203 A 6/1980 6,883,394 B2 4/2005 Koenig et al. GB 2356438 A 5/2001 6,887,184 B2 5/2005 Buchanan et al. JP 4366032 12/1992 6,888,992 B2 5/2005 Buchanan et al. JP 4306032 12/1992 6,898,992 B2 5/2005 Koenig et al. JP 82003303 8/1996 6,903,417 B2 10/2005 Koenig et al. JP 2000220762 A 8/2000											
6,789,658 B2 9/2004 Busold et al. EP 1420185 A2 11/2003 6,790,159 B1 9/2004 Yamamoto EP 1703178 A2 9/2006 6,819,997 B2 11/2004 Buchanan et al. EP 1703178 A2 9/2006 6,830,531 B1 12/2004 Buchanan et al. EP 1788288 A2 5/2007 6,830,531 B1 12/2004 Buchanan et al. EP 1950076 A1 7/2008 6,834,562 B2 12/2004 Buchanan et al. EP 1950076 A1 7/2008 6,868,949 B2 3/2005 Braford, Jr. GB 2036203 A 6/1980 6,868,949 B2 3/2005 Leising et al. GB 2036203 A 6/1980 6,883,394 B2 4/2005 Koenig et al. GB 2036203 A 6/1980 6,887,184 B2 5/2005 Buchanan et al. JP 4366032 12/1992 6,887,184 B2 5/2005 Koenig et al. JP 8200393 8/1996 6,909,955 B2 6/2005 Koenig et al. JP 8200393 8/1996 6,953,417 B2 10/2005 Koenig JP 2001020762 A 8/2000											
6,792,821 B1 9/2004 Yamamoto 6,819,997 B2 11/2004 Buchana et al. 6,830,331 B1 12/2004 Koenig et al. 6,832,978 B2 12/2004 Buchana et al. 6,834,562 B2 12/2004 Esly et al. 6,836,345 B2 12/2004 Esly et al. 6,836,345 B2 12/2004 Esly et al. 6,836,349 B2 3/2005 Braford, Jr. 6,869,382 B2 3/2005 Braford, Jr. 6,869,382 B2 3/2005 Braford, Jr. 6,883,394 B2 4/2005 Koenig et al. 6,883,394 B2 5/2005 Buchanan et al. 1	6,789,658	B2									
6,819,997 B2 11/2004 Buchanan et al. EP 1788288 A2 5/2007 6,830,531 B1 12/2004 Koenig et al. EP 1950076 A1 7/2008 6,832,978 B2 12/2004 Buchanan et al. EP 1950076 A1 7/2008 6,834,562 B2 12/2004 Esly et al. FR 1246517 10/1960 6,868,949 B2 3/2005 Braford, Jr. GB 2036203 A 6/1980 6,869,382 B2 3/2005 Leising et al. GB 2036203 A 6/1980 6,887,184 B2 5/2005 Koenig et al. JP 4366032 12/1992 6,898,999 B2 5/2005 Koenig et al. JP 8200393 8/1996 6,909,955 B2 6/2005 Vukovich et al. JP 2000220762 A 8/2000											
6,830,531 B1 12/2004 Koenig et al.	6,819,997	B2									
6,834,562 B2 12/2004 Esly et al. FR 124031 10/900 6,869,494 B2 3/2005 Braford, Jr. 6,869,382 B2 3/2005 Leising et al. 6,883,394 B2 4/2005 Koenig et al. 6,887,184 B2 5/2005 Buchanan et al. 6,898,992 B2 5/2005 Koenig et al. 6,989,995 B2 6/2005 Vukovich et al. 6,990,955 B2 10/2005 Koenig 6,953,417 B2 10/2005 Koenig 6,953,417 B2 10/2005 Koenig 7,0073,407 B2 7/2006 Nordstrom et al. 7,007,925 B2 8/2006 Nordstrom et al. 7,007,925 B2 7/2006 Stefina 7,073,407 B2 7/2006 Stefina 7,127,961 B2 10/2006 Braford et al. 7,127,961 B2 10/2006 Braford et al. 7,127,961 B2 10/2006 Braford et al. 7,11,187 B2 1/2007 Koenig et al. 7,211,187 B2 1/2007 Koenig et al. 7,311,187 B2 1/2008 Segi et al. 7,311,187 B2 1/2007 Koenig et al. 7,311,187 B2 1/2007 Koenig et al. 7,311,187 B2 1/2007 Koenig et al. 7,311,043 B2 10/2008 Segi et al. 7,318,512 B2 1/2008 Xiang et al. 7,856,999 B2 1/2010 Xiang et al. 7,856,999 B2 1/2010 Xiang et al. 7,856,999 B2 1/2010 Xiang et al. 7,856,999 B2 1/2001 Xiang et al. 7,856,999 B2 1/2002 Diemer et al. 7,856,999 B2 1/2001 Xiang et al. 7,856,999 B2 1/2002 Diemer et al. 7,856,999 B2 1/2001 Xiang et al. 7,856,999											
6,868,949 B2 3/2005 Braford, Jr. GB 2036203 A 6/1980 6,869,382 B2 3/2005 Koenig et al. GB 2356438 A 5/2001 GB,887,184 B2 5/2005 Buchanan et al. JP 4366032 12/1992 GB,889,992 B2 5/2005 Koenig et al. JP 8200393 8/1996 G,909,955 B2 6/2005 Koenig et al. JP 2000220762 A 8/2000											
6,883,394 B2 4/2005 Koenig et al. 6,887,184 B2 5/2005 Buchanan et al. 6,887,184 B2 5/2005 Koenig et al. 6,898,992 B2 5/2005 Koenig et al. 6,999,955 B2 6/2005 Vukovich et al. 6,953,417 B2 10/2005 Koenig 6,957,665 B2 10/2005 Shin et al. 6,969,043 B2* 11/2005 Hirata et al. 251/129.15 JP 2001206108 A 7/2001 7,007,925 B2* 3/2006 Nordstrom et al. 251/129.15 JP 2004-176895 A 6/2004 7,007,925 B2* 3/2006 Nordstrom et al. 251/129.15 JP 2005147403 6/2005 7,073,407 B2 7/2006 Stefina JP 2007263302 A 10/2007 7,127,961 B2 10/2006 Braford et al. 7,155,993 B2 1/2007 Koenig et al. 7,155,993 B2 1/2007 Koenig et al. 7,219,571 B2 5/2007 McCrary WO 2004005744 A1 1/2004 7,311,187 B2 1/2008 Koenig et al. 7,318,512 B2 1/2008 Bauer et al. 8001/0037698 A1 11/2001 Yamamoto et al. 2001/0037698 A1 11/2001 Diemer et al. Raw Machine translation for Foreign Patent Document JP-2009-	6,868,949	B2	3/2005	Braford, Jr.				Λ.			
6,887,184 B2 5/2005 Buchanan et al. 6,898,992 B2 5/2005 Koenig et al. 6,909,955 B2 6/2005 Vukovich et al. 6,953,417 B2 10/2005 Koenig 6,953,417 B2 10/2005 Shin et al. 6,969,043 B2* 11/2005 Hirata et al. 251/129.15 JP 2001206108 A 7/2001 7,007,925 B2* 3/2006 Nordstrom et al. 251/129.15 JP 2004-176895 A 6/2004 7,007,925 B2* 3/2006 Nordstrom et al. 251/129.15 JP 2005147403 6/2005 7,073,407 B2 7/2006 Stefina JP 2007263302 A 10/2007 7,127,961 B2 10/2006 Braford et al. 7,155,993 B2 1/2007 Koenig et al. 7,219,571 B2 5/2007 McCrary WO 2004005744 A1 1/2004 7,311,187 B2 1/2008 Bauer et al. 7,318,512 B2 1/2008 Bauer et al. 7,412,989 B2* 8/2008 Segi et al. 8/2001/0037698 A1 11/2001 Yamamoto et al. 2001/0037698 A1 11/2001 Piemer et al. Raw Machine translation for Foreign Patent Document JP-2009-											
6,898,992 B2 5/2005 Koenig et al. 6,909,955 B2 6/2005 Vukovich et al. 1P 2000220762 A * 8/2000									12/1992		
6,953,417 B2 10/2005 Koenig JP 2001206108 A 7/2001 6,957,665 B2 10/2005 Shin et al. JP 2003-247656 A 9/2003 6,969,043 B2* 11/2005 Hirata et al 251/129.15 JP 2004-176895 A 6/2004 7,007,925 B2* 3/2006 Nordstrom et al 251/129.15 JP 2005147403 6/2005 7,073,407 B2 7/2006 Stefina JP 2007263302 A 10/2007 7,127,961 B2 10/2006 Braford et al. JP 20098159 A 1/2009 7,155,993 B2 1/2007 Koenig et al. JP 2009908159 A 1/2009 7,219,571 B2 5/2007 McCrary WO 2004005744 A1 1/2004 7,311,187 B2 12/2007 Koenig et al. WO 2006086704 A2 8/2006 7,318,512 B2 1/2008 Bauer et al. WO 2006086704 A2 8/2006 7,412,989 B2* 8/2008 Segi et al	6,898,992	B2	5/2005	Koenig et al.							E16W 21/06
6,957,665 B2 10/2005 Shin et al. 6,969,043 B2* 11/2005 Hirata et al											F16K 31/06
6,969,043 B2 * 11/2005 Hirata et al											
7,073,407 B2 7/2006 Stefina JP 2007263302 A 10/2007 7,127,961 B2 10/2006 Praford et al. JP 20098159 A 1/2009 7,155,993 B2 1/2007 Koenig et al. JP 2009008159 A 1/2009 7,219,571 B2 5/2007 McCrary WO 2004005744 A1 1/2004 7,311,187 B2 1/2007 Koenig et al. WO 2006086704 A2 8/2006 7,318,512 B2 1/2008 Bauer et al. WO 2009128806 A1 10/2009 7,412,989 B2 8/2008 Segi et al. 137/625.64 7,431,043 B2 10/2008 Xiang et al. OTHER PUBLICATIONS 2001/0037698 A1 11/2001 Yamamoto et al. Raw Machine translation for Foreign Patent Document JP-2009-	6,969,043	B2 *	11/2005	Hirata et al 251/129.15				A			
7,127,961 B2 10/2006 Braford et al. JP 20098159 A 1/2009 7,155,993 B2 1/2007 Koenig et al. JP 2009008159 A * 1/2009 7,219,571 B2 5/2007 McCrary WO 2004005744 A1 1/2004 7,311,187 B2 1/2008 Koenig et al. WO 2006086704 A2 8/2006 7,318,512 B2 1/2008 Bauer et al. WO 2009128806 A1 10/2009 7,431,043 B2 10/2008 Xiang et al. OTHER PUBLICATIONS 2001/0037698 A1 11/2001 Yamamoto et al. Raw Machine translation for Foreign Patent Document JP-2009-											
7,155,993 B2 1/2007 Koenig et al. 7,219,571 B2 5/2007 McCrary WO 2004005744 A1 1/2004 7,311,187 B2 1/2007 Koenig et al. WO 2006086704 A2 8/2006 7,318,512 B2 1/2008 Bauer et al. WO 2009128806 A1 10/2009 7,412,989 B2 8/2008 Segi et al											
7,311,187 B2 12/2007 Koenig et al. WO 2006086704 A2 8/2006 7,318,512 B2 1/2008 Bauer et al. WO 2009128806 A1 10/2009 7,412,989 B2 * 8/2008 Segi et al	7,155,993	B2	1/2007	Koenig et al.							
7,318,512 B2 1/2008 Bauer et al. WO 2009128806 A1 10/2009 7,412,989 B2 * 8/2008 Segi et al						2004	4005744	A1	1/2004		
7,412,989 B2 * 8/2008 Segi et al											
7,856,999 B2 12/2010 Xiang et al. OTHER PUBLICATIONS 2001/0037698 A1 11/2001 Yamamoto et al. 2002/0014386 A1 2/2002 Diemer et al. Raw Machine translation for Foreign Patent Document JP-2009-					WU	Z005	91Z88U0	Al	10/2009		
2001/0037698 A1 11/2001 Yamamoto et al. 2002/0014386 A1 2/2002 Diemer et al. Raw Machine translation for Foreign Patent Document JP-2009-							OTHED	יו זם	DI ICATIO	NIC	
2002/0014386 A1 2/2002 Diemer et al. Raw Machine translation for Foreign Patent Document JP-2009-						,	OTHER	. rui	DLICATIO	MO	
					Raw Machine	tran	slation f	or Fo	oreign Pater	nt Docume	nt JP-2009-
					008159.*						

(56) **References Cited**

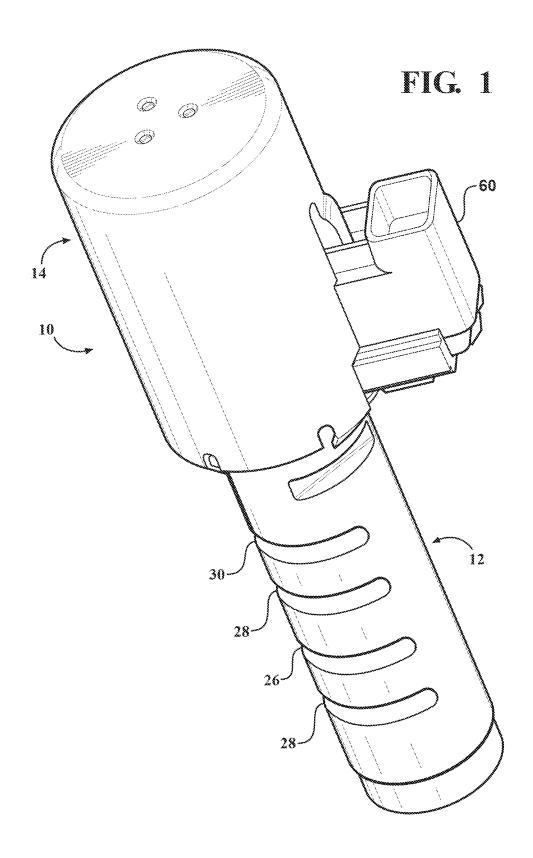
OTHER PUBLICATIONS

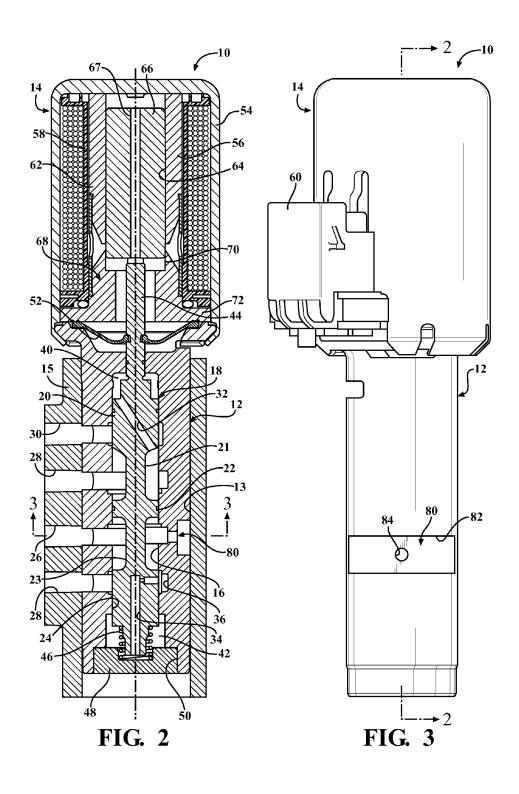
Raw Machine translation for Foreign Patent Document JP-2007-

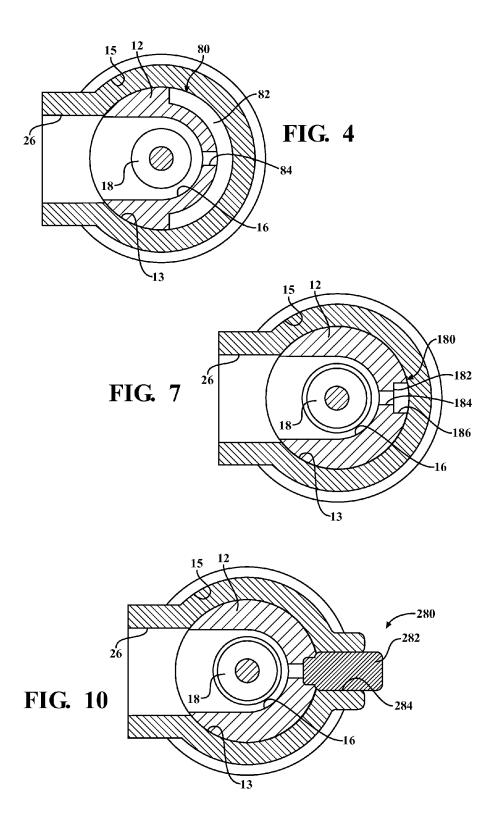
263302 referred as "Jatco" *
Machine translation of Toyoda (JP2004176895A Published on Jun. 24, 2004) provided by the EPO.*

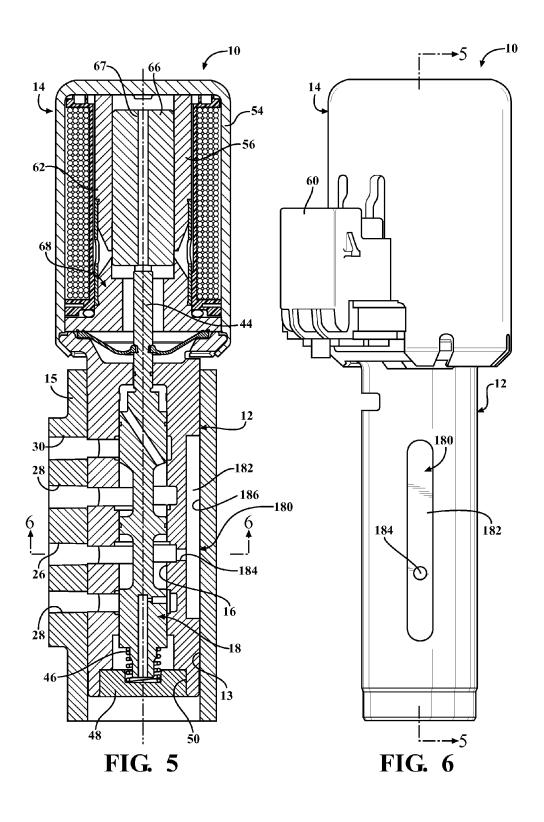
 $\label{eq:Jul.9} \ Jul.\ 9,\ 2010\ International\ Search\ Report\ for\ PCT/US2009/066674.$ Feb. 28, 2011 International Search Report for PCT/US2010/039425. Jan. 30, 2014 European Search Report for 10800235.3-175. Oct. 1, 2014 European Office Action for Application No. 10 800 235.3-1751.

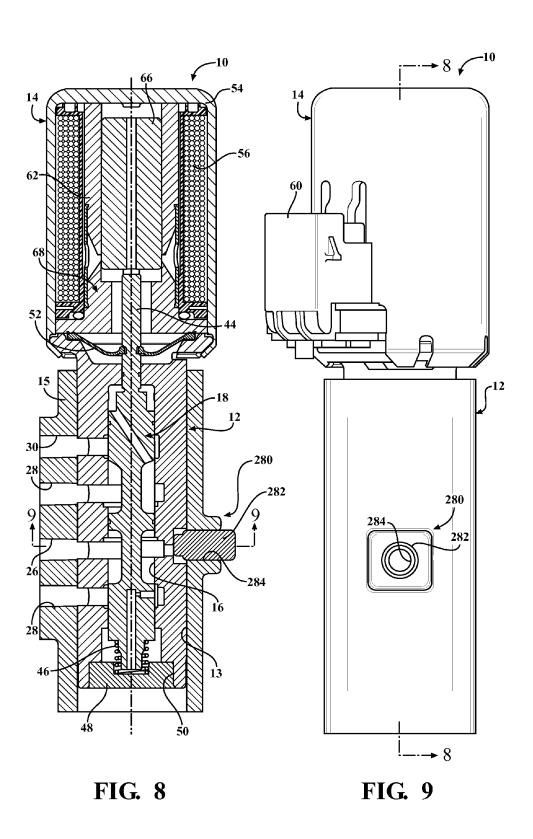
* cited by examiner

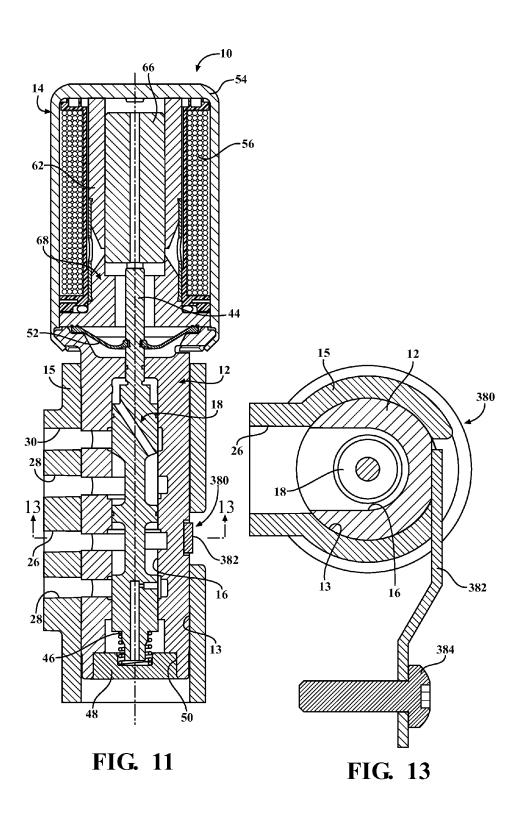


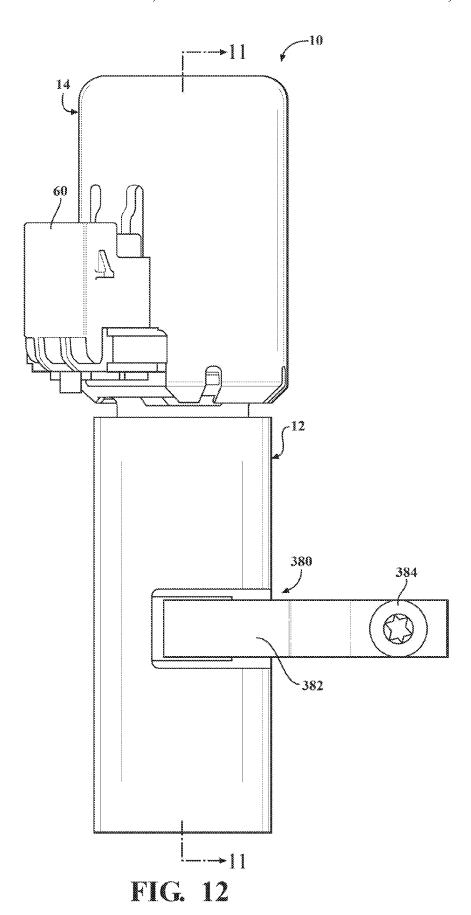












HYDRAULIC VALVE FOR USE IN A CONTROL MODULE OF AN AUTOMATIC TRANSMISSION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates, generally, to hydraulic valves and, more specifically, to hydraulic valves for use in the control modules of automatic transmissions.

2. Description of the Related Art

Generally speaking, land vehicles require a powertrain consisting of three basic components. These components include a power plant (such as an internal combustion engine), a power transmission, and wheels. The power transmission component is typically referred to simply as the "transmission." Engine torque and speed are converted in the transmission in accordance with the tractive-power demand of the vehicle.

Most automatic transmissions are controlled by hydraulically actuating the various components within the transmission. Thus, it is important to provide a stable hydraulic pressure for these devices. To this end, a pump is employed to provide pressurized hydraulic fluid for the control and actuation of the transmission. In addition, the clutches and gear assemblies are lubricated and cooled by a secondary flow of the hydraulic fluid. Typically, the pump is mechanically driven by a power take-off from the engine. Thus, the hydraulic pressure delivered from the pump increases as the pump speed increases in response to an increase in engine speed. Since hydraulically actuated devices respond in a predetermined and precise manner for the given pressure applied to actuate them, inaccurate control of the hydraulic pressure causes inaccurate operation and control of the automatic 35 transmission

To address the changes in the hydraulic pressure delivered by the pump as engine speed changes, automatic transmissions typically include a hydraulic control module that employs a plurality of hydraulic valves. A number of the 40 valves of the type commonly employed in the hydraulic circuit of the transmission may include a valve member slidably disposed within a valve body. The valve member moves back and forth over the various ports of the valve body to direct and control the fluid flow between the ports. The valve bodies are 45 typically received in corresponding bores formed in the control module.

The hydraulic valves may be fixedly mounted to the control module in a number of ways. For example, the valve assembly may employ a flange that is bolted to the control module using 50 fasteners. Alternatively, the valve may employ O-rings or other seals disposed about the outer circumference of the valve body and that sealingly engage with the inner diameter of the bore formed in the control module.

While these mounting systems have generally worked for 55 their intended purpose, certain disadvantages are presented when using these mounting strategies. For example, flange-mounted valves suffer from the disadvantage of high-costs associated with the number of fasteners needed to mount a plurality of valves to the control module. In addition, there is an ongoing need to minimize the space or "packaging" associated with transmission components, including the control module. However, both flange-mounted and O-ring sealed hydraulic valves suffer from the disadvantage that they are relatively long and thus present a larger profile. This requires 65 more space to mount them to the control module, and thereby increases the "package" of the control module.

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Partly due to these deficiencies, hydraulic valves were developed that have valve bodies that are "slip fit" into the bores formed in the control module. The tolerance between the valve body and the bore are designed such that the valve assemblies are fixedly retained in the bore. This "slip fit" mounting approach allows for a shorter valve body and thus a lower profile valve assembly. This also allows the size or "package" of the control module to be reduced.

Unfortunately, valve assemblies that are slip-fit mounted to control modules used in automatic transmissions suffer from the disadvantage that they tend to leak around the outer diameter of the valve body in the bore. Leakage of this type is not insignificant when the number of hydraulic valves employed for a transmission control unit is taken into consideration. Thus, larger capacity pumps have been employed in order to account for this defect. However, larger capacity pumps have higher costs to manufacture, and require more energy to operate. Alternatively leakage may be reduced by employing tighter clearances and less tolerance between the valve body 20 and the bore in the control module. However, this requires additional machining and also increases the cost of manufacturing the valve and the control module. In view of the ongoing need to reduce costs and improve fuel economy, the slip-fit approach to mount a hydraulic valve to a transmission control module has been deemed problematic.

Thus, there remains a need in the art for a hydraulic valve that may be quickly and easily slip-fit mounted to a hydraulic control module for an automatic transmission at low cost, and that has a low profile and facilitates a smaller package for the control module. In addition, there remains a need in the art for a slip-fit mounted hydraulic valve having improved leakage characteristics so that smaller capacity pumps having lower energy requirements may be used to pressurize the transmission's hydraulic circuit.

SUMMARY OF THE INVENTION

The present invention overcomes the deficiencies in the related art in a hydraulic valve assembly that is adapted to be mounted to a transmission control module. The hydraulic valve includes a valve body that is adapted to be received and retained in the bore of the transmission control module. The valve body has a valve bore extending axially along the length of the valve body. At least one pressure supply port provides fluid communication between a source of pressurized fluid and the valve bore. In addition, at least one pressure control port provides fluid communication between the valve bore and a component controlled by the transmission control unit. A valve member is supported in the valve bore and is selectively movable between predetermined positions to direct pressurized fluid between the pressure supply port and the pressure control port. In addition, the hydraulic valve assembly of the present invention includes a biasing mechanism that is responsive to the flow of hydraulic fluid through the valve body and that generates a biasing force acting on the valve body in a direction toward the pressure supply port to improve the seal of the valve body against the bore of the transmission control module at the pressure supply port.

In this way, the hydraulic valve assembly of the present invention may be quickly and easily slip-fit mounted to the hydraulic control module for an automatic transmission without the need for additional fasteners, seals, and the like. The particular mounting strategy employed herein also provides for a low-profile and that facilitates a smaller package for the control module. In addition, the slip-fit mounted hydraulic valve assembly of the present invention has improved leakage characteristics so that smaller capacity pumps having lower

energy requirements may be employed to pressurize the transmission's hydraulic circuit.

Other objects, features, and advantages of the present invention will be readily appreciated, as the same becomes better understood after reading the subsequent description 5 taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective elevational view of one representative embodiment of a hydraulic valve assembly of the present invention; 10

FIG. 2 is a cross-sectional side view of one embodiment of the hydraulic valve assembly of the present invention;

FIG. 3 is an elevational top view of the valve body of the 15 hydraulic valve illustrated in FIG. 2;

FIG. 4 is a cross-sectional end view of the valve body of the hydraulic valve illustrated in FIG. 2;

FIG. 5 is a cross-sectional side view of another embodiment of the hydraulic valve assembly of the present invention; 20

FIG. **6** is an elevational top view of the valve body of the hydraulic valve assembly illustrated in FIG. **5**;

FIG. 7 is a cross-sectional end view of the valve body of the hydraulic valve assembly illustrated in FIG. 5;

FIG. **8** is a cross-sectional side view of another embodiment of the hydraulic valve assembly of the present invention;

FIG. 9 is an elevational top view of the valve body of the hydraulic valve assembly illustrated in FIG. 8;

FIG. 10 is a cross-sectional end view of the valve body of the hydraulic valve assembly illustrated in FIG. 8;

FIG. 11 is a cross-sectional side view of another embodiment of the hydraulic valve assembly of the present invention;

FIG. 12 is an elevational top view of the valve body of the hydraulic valve assembly illustrated in FIG. 11; and

FIG. 13 is a cross-sectional end view of the valve body of 35 the hydraulic valve assembly illustrated in FIG. 11;

DETAILED DESCRIPTION

A hydraulic valve assembly of the present invention is 40 generally indicated at 10 in FIGS. 1, 2-3, 5-6, 8-9, and 11-12, where like numerals are used to designate like structure throughout the figures. The hydraulic valve 10 is particularly useful as a component of a control module of a hydraulic transmission. However, from the description that follows, 45 those having ordinary skill in the art will appreciate that the hydraulic valve 10 of the present invention is not limited for use solely in a hydraulic control module. Thus, reference to such control modules in the description that follows is only for purposes of context and to better describe the features of 50 the present invention. The hydraulic valve assembly 10 of the present invention is illustrated in four embodiments shown in FIGS. 2-4; 5-7; 8-10; and 11-13. Each of these embodiments has common components that will be described first with reference to FIGS. 1-3. Each of the common components is 55 designated with the same reference numeral throughout the figures. The differences between the embodiments will be described with reference to specific figures using reference numbers increased by 100 throughout the figures. The hydraulic valve 10 includes a valve body, generally indicated 60 at 12, and a solenoid assembly, generally indicated at 14. As noted above, both of these components will be described in greater detail below with reference to FIGS. 1-3.

More specifically, the valve body 12 may define a cylindrical sleeve-like element that is adapted to be received in a 65 corresponding bore 13 formed in a hydraulic control module that is representatively illustrated at 15. The control module is

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in communication with a source of pressurized fluid (such as a hydraulic pump) that is delivered to the valve body 12 as is commonly known in the art. The valve body 12 may be fixedly retained in the corresponding bore in the control module in any manner known in the related art. However, in the representative example illustrated in this figure, the valve body is designed to be slip-fit into the bore and retained by interference between the outer circumference of the valve body and the inner circumference of the corresponding bore as will be described in greater detail below.

The valve body 12 includes a valve bore 16 and a valve member, generally indicated at 18 that is movably supported in the valve body 12 between predetermined positions as will be described in greater detail below. The valve member 18 includes a plurality of lands 20, 22 and 24 that are disposed in sealing engagement with the valve bore 16 and employed to direct the flow of hydraulic fluid through the valve body 12. A reduced diameter portion 21 may extend between lands 20 and 22 while a reduced diameter portion 23 may extend between lands 22 and 24. The valve body 12 includes at least one pressure supply port 26 that establishes fluid communication between the source of pressurized hydraulic fluid and the valve bore 16. The valve body 12 also includes at least one pressure control port 28 that establishes fluid communication between the valve bore 16 and a component to be controlled by the hydraulic valve and the valve bore 16. These components may include any number of various clutches, synchronizers, or other hydraulically actuated components commonly found in a transmission.

In the representative example illustrated here, the valve body includes a pair of pressure control ports 28 that establish fluid communication between the valve bore 16 and at least one component to be controlled by the hydraulic valve. The valve body 12 may also include at least one exhaust port 30 for exhausting pressurized fluid from the valve body when the hydraulic valve assembly 10 is in its "off" position. The valve body 12 also includes a feedback channels 32, 34 are formed generally through lands 20 and 24. The feedback channel 32 extends through the land 20 to establish fluid communication between the void defined by reduced diameter portion 21 of the valve member 18 and the valve bore 16 and a control chamber 40. The control chamber 40 is defined in the valve bore closest to the solenoid 14. The feedback channel 34 extends through land 24 so as to establish fluid communication between an annular port 36 defined in the valve bore 16 and a control chamber 42. The control chamber 42 is located in the valve bore opposite from the control chamber 40. The annular port 36 is in fluid communication with one of the control ports 28.

The valve member 18 includes a push rod 44 that is mechanically influenced by the solenoid assembly 14 to move the valve member 18 downwardly as viewed in FIG. 2. A biasing member 46 is employed to bias the valve member 18 in a direction opposite the movement induced by the solenoid assembly 14, as will be described in greater detail below. In the representative embodiment illustrated herein, the biasing member is a coiled return spring 46 disposed between the land 24 of the valve member 18 and a plug 48 that closes the otherwise open end 50 of the valve bore. From the description that follows, those having ordinary skill in the art will appreciate that the valve body 12, the valve member 18, as well as all associated ports and other related structure can take a number of different forms while still performing the function required by the solenoid actuated hydraulic valve of the present invention. Thus, the hydraulic valve of the present invention is in no way limited to the specific structure of the valve body 12 and all related components illustrated herein.

The valve body 12 is operatively mounted to the solenoid assembly 14 in a manner that seals the solenoid assembly 14 from contact with hydraulic fluid flowing through the valve body 12. To this end, the pushrod 44 is received through an opening in a diaphragm 52 that is fixedly clamped between the valve body 12 and the solenoid assembly 14. The solenoid assembly 14 includes a housing or "can" 54 and a solenoid coil 56 supported in the housing 54 about a bobbin 58. The solenoid coil 56 consists of wire wrapped around the bobbin 58 and that generates an electromagnetic flux when subjected to a current flowing through the coil 56 as is commonly known in the art. To this end, the solenoid assembly 14 is in communication with a source of electrical power via the connector assembly 60 shown in FIGS. 1 and 3.

A flux tube 62 is fixedly mounted in the housing 54 and 15 defines an inner space 64. An armature 66 is movably supported in the space 64 defined by the flux tube 62 under the influence of the electromagnetic flux as will be described in greater detail below. The armature 66 may also include a vent port 67 that allows the armature 66 to move reciprocally 20 within the space 64 defined by the flux tube 62. The solenoid assembly 14 also includes a pole piece, generally indicated at 68, that is fixedly supported in the housing 54 and disposed opposite the armature 66. As best shown in FIG. 2, the pole piece 68 has a shunt portion, generally indicated at 70 that 25 faces the armature 66 as shown in FIG. 2. The pole piece 68 includes an annular base 72. The armature 66 is movable toward the pole piece 18 under the influence of the electromagnetic flux generated by a pulse of current flowing through the solenoid coil **56**. In turn, the armature **66** acts on the valve 30 member 18 through the pushrod 44 to move the valve member 18 between predetermined positions.

Pressurized hydraulic fluid flows through the pressure supply port 26, past lands 20, 22 or 24, through the valve bore 16 and out the pressure control ports 28 or exhaust port 30 as 35 dictated by the position of the valve member 18 in the valve bore that is moved in response to the action of the solenoid assembly 14 and the return biasing member 46. Pressurized hydraulic fluid also flows through the feedback channels 32, 34 to balance the pressure on either side of the valve member 40. In this way, the hydraulic valve assembly 10 is controlled to direct hydraulic fluid from the pressure supply port 26 through the valve bore 16 and to the pressure control ports 28 or exhaust port 30 as the need arises.

Thus, the hydraulic valve assembly 10 of the present inven- 45 tion is designed to be slip-fit into the bore formed in the hydraulic control module. This approach allows the use of shorter valve assemblies having a lower profile which translates into a control module that likewise has a lower profile. This feature improves packaging aspects of both the hydrau- 50 lic valve assembly as well as the control module with which it may be used. However, the slip-fit hydraulic valve assemblies known in the related art typically suffer from the disadvantage that they tend to leak around the supply ports. Leakage around the supply ports also tends to cause leakage along 55 the length of the valve body at the interface with the bore in the control module. In order to address this defect, each of the embodiments of the hydraulic valve assembly 10 of the present invention employ a biasing mechanism, generally indicated at 80, 180, 280, and 380 in FIGS. 2-4, 5-7, 8-10 and 60 11-13, respectively. Each of the biasing mechanisms generate a biasing force that acts on the valve body in a direction toward the pressure supply port to seal the valve body against the bore of the transmission control module at the pressure supply port. In this way, leakage around the pressure supply port and other places along the valve body are reduced. Additional details of each of the biasing mechanisms employed in

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the embodiments illustrated in the figures will now be described in greater detail below with reference to the specific figure illustrating that embodiment using reference numbers that increase by a factor of 100 between the different embodiments

More specifically, and referring now to FIG. 2, the biasing mechanism illustrated with respect to the hydraulic valve assembly shown therein is responsive to the flow of hydraulic fluid through the valve body to generate this biasing force. To this end, the biasing mechanism 80 illustrated in FIGS. 2-4 includes a channel 82 formed on the outer circumference of the valve body opposite to the pressure supply port 26. The channel 82 is in fluid communication with the pressure supply port via passage 84 and is adapted to define a hydraulic biasing reservoir in conjunction with an arcuate portion of the bore and the transmission control mechanism. Hydraulic fluid flowing into the reservoir generates a force acting in a direction toward the pressure supply port 26 to seal the pressure supply port 26 against the bore of the transmission control module. As best shown in FIGS. 3-4, the channel extends substantially arcuately about the longitudinal axis of the valve

Alternatively, and in the embodiment illustrated in FIGS. 5-7, the biasing mechanism 180 includes a channel 182 that extends substantially in the direction of the longitudinal axis of the valve bore 16. More specifically, the channel 182 is in fluid communication with the pressure supply port 26 via passage 184 and is adapted to define a hydraulic biasing reservoir in conjunction with an axially extending portion of the bore 13 of the transmission control module 15. Hydraulic fluid flowing into the reservoir defined by the channel 182 generates a force acting in a direction toward the pressure supply ports 26 as well as control port 28 and exhaust port 30 to seal the ports against the bore 13 of the transmission module 15. Thus, in both embodiments illustrated in FIGS. 2-7, the channels 82 and 182 generate a force acting in a direction toward the pressure supply port to seal the pressure supply port against the bore of the transmission control module.

Alternatively, the biasing mechanisms 80 or 180 may include a bladder that is disposed in a respective channel 82, 18. In this way, the hydraulic valve assembly 10 is controlled to direct hydraulic fluid from the pressure supply port 26 through the valve bore 16 and to the pressure control ports 28 or exhaust port 30 as the need arises.

Thus, the hydraulic valve assembly 10 of the present invention is designed to be slip-fit into the bore formed in the hydraulic control module. This approach allows the use of shorter valve assemblies having a lower profile which translates into a control module that likewise has a lower profile.

Referring now to FIGS. 8-10, the biasing mechanism 280 of the present invention may include a set screw 282 that is disposed through a threaded aperture 284 defined at the outer portion of the control module 15 so that the screw 282 bears against the outside circumference of the valve body 12 opposite to the pressure supply port 26. The set screw 282 generates a force acting in a direction toward the pressure supply port 26 to seal the pressure supply port 26 against the bore of the transmission control module. To this end, the set screw 282 may be threadably and adjustably received in the threaded aperture 284. Adjustment of the set screw 282 in the aperture 284 adjusts the biasing force generated by this screw 282.

Finally, and referring specifically to FIGS. 11-13, the biasing mechanism 380 may include a bracket 382 that is disposed at the outer circumference of the valve body 12 opposite to the pressure supply port 26. The bracket 382 may be mounted to associated structure via a fastener such as a bolt

384 or the like. The bracket **382** generates a biasing force acting in a direction toward the pressure supply port **26** to seal the pressure supply port **26** against the bore **13** of the transmission control module **15** in the same way as is done with respect to the embodiments discussed above.

In this way, the biasing mechanisms **80**, **180**, **280**, and **380** illustrated in FIGS. **2-13** act to reduce any leakage that may otherwise occur around the valve body **12** in a slip-fit configuration, while still retaining the advantages related to a lower profile valve assembly as well as a hydraulic control 10 module.

The invention has been described in an illustrative manner. It is to be understood that the terminology that has been used is intended to be in the nature of words of description rather than of limitation. Many modifications and variations of the 15 invention are possible in light of the above teachings. Therefore, within the scope of the claims, the invention may be practiced other than as specifically described.

We claim

1. A hydraulic valve assembly (10) adapted to be mounted 20 to a transmission control module (15), said hydraulic valve comprising:

- a valve body (12) adapted to be received and retained in the bore (13) of the transmission control module (15), said valve body (12) having a valve bore (16) extending axially along the length of said valve body (12), at least one pressure supply port (26) providing fluid communication between a source of pressurized fluid and said valve bore (16), and at least one pressure control port (26) providing fluid communication between said valve bore (16) and a component controlled by the transmission control unit, a valve member (18) supported in said valve bore (16) and selectively moveable between predetermined positions to direct pressurized fluid between said pressure supply port (26) and said pressure control ³⁵ port (28);
- a channel (80) formed on the outer circumference of said valve body (12), said channel having first and second ends and extending substantially arcuately about the longitudinal axis of said valve bore (16) opposite to said pressure supply port (26) such that said first and second ends are disposed in spaced angular relationship with respect to the longitudinal axis of said valve bore (16), said channel being in fluid communication with said

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pressure supply port (26) and adapted to define a hydraulic biasing reservoir generating a force acting in a direction toward said pressure supply port (26) to improve the seal of said pressure supply port against the bore (13) of the transmission control module (15).

- 2. The hydraulic valve assembly (10) as set forth in claim 1 further including a bladder (186) disposed in said channel (82) and between said channel (82) and the bore (13) defined in the transmission control module (15).
- 3. A hydraulic valve assembly (10) adapted to be mounted to a transmission control module (15), said hydraulic valve comprising:
 - a valve body (12) adapted to be received and retained in the bore (13) of the transmission control module (15), said valve body (12) having a valve bore (16) extending axially along the length of said valve body (12), at least one pressure supply port (26) providing fluid communication between a source of pressurized fluid and said valve bore (16), and at least one pressure control port (28) providing fluid communication between said valve bore (16) and a component controlled by the transmission control unit, a valve member (18) having at least two lands supported in said valve bore (16), said valve member (18) selectively moveable between predetermined positions to direct pressurized fluid between said pressure supply port (26) and said pressure control port (28);
 - a channel (182) formed on the outer circumference of said valve body (12) and extending substantially in the direction of the longitudinal axis of said valve bore (16) opposite to said pressure supply port (26) and so as to substantially span the distance between said at least two lands of said valve member (18), said channel (182) being in fluid communication with said pressure supply port (26) and adapted to define a hydraulic biasing reservoir generating a force acting in a direction toward said pressure supply port (26) to improve the seal of said pressure supply port against the bore (13) of the transmission control module (15).
- 4. The hydraulic valve assembly (10) as set forth in claim 3 further including a bladder (186) disposed in said channel (182) and between said channel (182) and the bore (13) defined in the transmission control module (15).

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